

1

3,493,503

METHOD OF PRODUCING A PROTEIN-FREE FLUID

Morris Mass, Kew Gardens, N.Y., assignor to Haematronics, Inc., New Rochelle, N.Y., a corporation of New York

Filed May 19, 1967, Ser. No. 639,742

Int. Cl. B01t 9/02

U.S. Cl. 210—59

4 Claims

ABSTRACT OF THE DISCLOSURE

The present invention includes apparatus for producing a protein-free fluid and comprises a syringe for initially containing a protein-bearing fluid and filter means co-operating with the syringe for inhibiting passage of protein therethrough.

This invention relates to apparatus for measuring and indicating color density with respect to a standard, and more particularly to a syringe for producing a protein-free fluid.

Use of protein-free filtrates and fluids are known. Present methods for preparing and obtaining protein-free filtrates include the use of funnels, fluted filter paper and centrifuging apparatus. Obvious drawbacks include the large amount of time required to prepare the fluid and thus make present methods undesirable and costly in the field of clinical analysis.

An object of the present invention is to provide a novel syringe structure for use in producing a protein-free fluid.

Another object of the present invention is to provide a method of producing a protein-free fluid including, in a preferred embodiment, the use of a syringe.

Still another object of the present invention is to provide an extremely inexpensive and very rapid method and apparatus for producing a filtrate.

A further object of the present invention is to provide improved apparatus for measuring and indicating color density with respect to a standard in which, in a preferred embodiment, novel colorimeter apparatus is employed for determining the sugar content or other property of a blood-donor's blood.

A still further object of the present invention is to provide a disposable syringe for use in producing a filtrate wherein a pretreated insert is employed in forcing a fluid such as the mixture of fingertip blood and a reagent through the insert and into a receptacle.

Yet another object of the present invention is to provide a disposable syringe structure having a barrel and a plunger wherein the plunger is removable and replaceable.

Another object is to provide means for indicating the properties of blood wherein fingertip blood is utilized and the need for removal of venous blood from the donor is eliminated.

The present invention fulfills the aforementioned objects and overcomes limitations and disadvantages of prior art solutions to problems by providing a disposable syringe structure for use in preparing a protein-free fluid. In one embodiment of the present invention, a disposable syringe includes a barrel portion and a plunger assembly which matingly cooperate and are constructed to permit removal of the plunger assembly from the barrel. The barrel comprises an elongated substantially cylindrical middle portion which extends from a perforated end to an open end having flared bearing surfaces. The open end is adapted to receive a disposable and removable filter insert which, during use of the present embodiment, is

2

disposed within the barrel adjacent the perforated end thereof. Insertion of the filter insert is accomplished by placing a pretreated filter paper disc into the entrance portion of the open end of the barrel and matingly engaging the plunger assembly into the barrel so as to bias the insert further into the barrel and downward towards the perforated end until it is in place.

The plunger assembly includes a shank portion which extends between a bearing cap having a bearing surface for pressure to be applied thereto with the hand of the user of the present invention, and a resilient piston having at least one diameter which is adapted to slidably engage the interior portion of the barrel such that a liquid-tight seal is achieved during movement of the plunger toward and away from the perforated end of the barrel.

In operation, the barrel is placed in one hand of the user; the filter insert is placed into the entrance portion of the open end of the barrel; the plunger assembly is used to force the insert into the bottommost portion of the barrel adjacent the perforated end thereof; the plunger assembly is thereafter removed from the barrel; a suitable and predetermined reagent in selected quantities is placed through the open end of the barrel and into the inside thereof; a selected amount of fingertip blood is added to the reagent within the barrel; the two substances are mixed, such as by tapping an extremity of the barrel; the plunger assembly is inserted into the barrel and, by forcing the plunger assembly toward the perforated end, the piston assembly forces the mixture within the barrel to pass through the filter insert which will permit only protein-free fluid to pass therethrough and out of the barrel through the perforations in the perforated end and thereafter into a suitable receptacle.

The invention will be more clearly understood from the following description of a specific embodiment of the invention, together with the accompanying drawing, wherein similar reference characters denote similar elements throughout the several views, in which:

FIG. 1 is an exploded perspective view of the elements of a syringe assembly;

FIG. 2 is a fragmentary sectional elevation view of the syringe assembly shown in FIG. 1;

FIG. 3 is an enlarged bottom view of the perforated end of the barrel assembly shown in FIG. 1;

FIG. 4 is a sectional elevational view of a test tube shown fragmentarily in FIG. 2, for use in a colorimeter; and

FIG. 5 is a view taken along the line V—V of FIG. 2.

Referring now in detail to the drawing, in FIG. 1 a syringe assembly 1 is shown in an exploded view as including a barrel assembly 2, a filter insert 3 and a plunger assembly 4.

Barrel assembly 2 includes a cylindrical middle portion 5 which extends between a perforated end 6 and an open end 7. Perforated end 6 has a plurality of holes 8 formed therethrough, which holes are adapted to permit fluid to pass through perforated end 6 at a predetermined rate as a function of the force exerted by the plunger assembly. FIG. 3 illustrates, in one embodiment, five holes formed through end 6.

Flanged or flared portions 9 form an integral part of barrel assembly 2 and extend substantially perpendicularly in diametrically opposite directions from middle portion 5. Bearing surfaces 10 are provided for gripping of the underside of flared portions 9 by the fingers of the user of syringe assembly 1. The thickness of flared portions 9 is predetermined in order to withstand the stresses induced in flared portions 9 during the bearing of the fingers of the user against the bearing surfaces 10. Bearing surfaces 10 assume a semielliptical shape for the flared portions shown in the embodiment in FIG. 1.

Filter insert 3, as shown in FIG. 1, includes a cylindrical disc having surfaces 11 which lie in substantially parallel planes. The thickness of insert 3 is predetermined and may be a function of the volume and mass flow rates that insert 3 will accommodate.

Plunger assembly 4 includes a shank portion 12 having a cross-shaped ribbed cross section including four outwardly extending ribs 13. Shank portion 12 extends between a bearing cap 14 and a piston assembly 15. Bearing cap 14 is integral with shank portion 12 and may be either formed therewith, such as by molding or machining, or may be attached to shank portion 12 such as by welding or fusing methods. Bearing cap 14 comprises a bearing surface 16 (FIG. 2) which is void of sharp edges and is of circular dimensions suitable for the application of the thumb or other portion of the hand of a user thereto.

FIG. 5 illustrates a preferred cross-sectional construction of shank portion 12 wherein favorable strength properties may be achieved. Letter H designates the maximum overall cross-sectional dimension of shank portion 12 and letter *h* designates the thickness of ribs 13 in the symmetrical configuration shown in FIG. 5. The shear and bending properties of the shank portion of plunger assembly 4 may be predetermined by selecting values for H and *h* which will yield favorable characteristics, depending upon the applications in which the present syringe structure will be used. In computing the shear strength of shank portion 12, the cross-sectional area A, being a function of H and *h* is

$$A=2Hh-h^2$$

while the moment of inertia I, for computing bending stresses induced in shank portion 12, is

$$I=\frac{H^3h+Hh^3-h^4}{12}$$

Piston assembly 15 includes a resilient member 16 of stepped diameters and having conical portions. Portion 17 originates at a first diameter and has a truncated conical cross-section terminating at portion 18. Portion 18 is cylindrical and possesses a constant given diameter of absolute magnitude less than diameter D, which designates the inside bore diameter of middle portion 5 of barrel assembly 2. Portion 19 originates at portion 18 and has a cross-section which is substantially a mirror image of the cross-section of portion 17, thereby terminating at said first diameter. Portion 20 is of conical cross-section with the apex thereof directed toward perforated ends 6 when plunger assembly 4 is inserted into barrel assembly 2. Said first diameter may be equal or slightly greater than diameter D of middle portion 5 and, in a preferred embodiment wherein the first diameter is larger than diameter D, the piston assembly 15 and its associated integral portions 17-20 which make up member 16 will yield and bear against the inside surface 21 of middle portion 5 of barrel assembly 2. Thus the engagement of member 16 against inside surface 21 will provide a liquid-tight seal which will prevent the passage of fluid past member 16 during relative movement of member 16 with respect to portion 50.

Member 16 may be removable and of a predetermined and selected cross-section apart from that shown in FIG. 2 such that, depending upon the sealing characteristics desired, member 16 may be selected from a series of disposable members having different physical configurations. Portion 22 of plunger assembly 4 is provided with means for removably securing member 16 thereto.

Filter insert 3, in one embodiment in the present invention, is a pretreated disc of filter paper. In preparing insert 3, a large sheet, from which several discs are cut, is soaked in a solution in which sodium tungstate is mixed or dissolved in water. After the sheet is soaked

in the tungstate solution, it is removed and dried and thereafter suitable sized inserts are cut from the sheet.

In operation, the user of syringe assembly 1 places filter insert 3 inside open end 7 and, with the use of plunger assembly 4, pushes insert 3 down into middle portion 5 until the insert is adjacent perforated end 6 as shown in FIG. 2. Thereafter, plunger assembly 4 is removed from barrel assembly 2 and barrel assembly 2 is caused to stand vertically as shown in FIG. 2. A stable tungstic acid solution or mixture is splaced, in predetermined amounts, into barrel assembly 2, which acid may contain sodium tungstate. Thereafter, predetermined amounts of fingertip blood, as opposed to venous blood, are added to the solution within barrel assembly 2. The two fluids are mixed, such as by tapping perforated end 6 with the finger tip until a mixture is achieved. Plunger assembly 4 is then inserted into barrel assembly 2 in the position in FIG. 2 and forced with the hand of the user into the barrel assembly such that fluid 23 within middle portion 5 is forced against insert 3. Since insert 3 is adapted to permit only protein-free fluid to pass therethrough, such protein-free fluid emerges from the downward surface 11 of insert 3 and flows through holes 8 in perforated end 6 and thereafter into a test tube 24 (FIG. 2). Thus, as seen in FIG. 4, test tube 24 will contain fluid 25 which is protein-free and suitable for use in apparatus such as a colorimeter for measuring sugar content of blood.

A copper reagent in the form of a solution containing one part of 5% CUSO_4 , two parts of citric acid, and 1/100 of a part of 85% phosphoric acid is added to the protein-free fluid collected in the test tube 24 or other suitable receptacle. Glucose in the blood of the donor will engage copper in the copper reagent to form a mixture. This mixture is placed in boiling water for a predetermined time, such as five minutes, which will result in the formation of cuprous oxide, the density of the cuprous oxide being proportional to the amount of glucose in the blood. The mixture is thereafter removed and allowed to cool. A color reagent is added to the cooled mixture, the color reagent in the form of phosphomolybdic acid which contains molybdic anhydride, sodium carbonate and a stabilizer (EDTA). The molybdenum in the coloring agent will react with the cuprous oxide to form a blue color, the intensity of the blue color being a function of and being proportional to the density of the cuprous oxide in the cooled solution. Thus it is seen that the color intensity of the final fluid is directly proportional to the amount of glucose in the blood of the blood donor from which fingertip blood was taken. By measuring the color intensity of this solution with respect to a standard solution, the glucose reading of a person's blood may be rapidly and easily determined.

It is this blue color solution that is thereafter inserted into a colorimeter, such as disclosed in my U.S. patent application, Ser. No. 685,431, filed on Nov. 24, 1967, such that a light source is passed through the solution and the light emerging from the solution impinges a photoelectric cell after passing through a suitable filter, which photoelectric cell is electrically connected to a meter which will give the user of the meter and the reader thereof an immediate indication of the percentage of glucose in the blood of a person who donates fingertip blood.

It is, of course, within the scope of the present invention to include the disclosed method and apparatus for determining other properties of fluids such as blood, besides glucose.

The embodiment of the invention particularly disclosed is presented merely as an example of the invention. Other embodiments, forms and modifications of the invention coming within the proper scope of the appended claims will of course readily present themselves to those skilled in the art.

What is claimed is:

1. A method of producing a protein-free fluid, comprising the steps of placing disposable filter means into an opening of the barrel of a syringe, pushing said filter means into said barrel with a plunger assembly, removing said plunger assembly from said barrel, placing a pre-determined amount of tungstic acid reagent through said opening into the barrel, adding a fingertip blood of a donor to the reagent within said barrel, causing said blood and said reagent to mix with one another to form a mixture, reinserting said plunger assembly into said barrel and forcing said mixture against and through said filter means thereby causing a protein-free filtrate to be discharged from the syringe.

2. The method as defined in claim 1, wherein said filter is a disc of filter paper comprising impregnating said paper with a tungstate solution before passing said mixture therethrough.

3. A method of producing a protein-free fluid, comprising the steps of placing disposable filter means into an opening of the barrel of a syringe, pushing said filter means into said barrel with a plunger assembly, removing said plunger assembly from said barrel, placing a pre-determined amount of sodium tungstate reagent through said opening into the barrel, adding a fingertip blood of a donor to the reagent within said barrel, causing said blood and said reagent to mix with one another to form a mixture, reinserting said plunger assembly into said

barrel and forcing said mixture against and through said filter means thereby causing a protein-free filtrate to be discharged from the syringe.

4. The method as defined in claim 3, wherein said filter is a disc of filter paper comprising impregnating said paper with a tungstate solution before passing said mixture therethrough.

References Cited

UNITED STATES PATENTS

2,306,325	12/1942	Allam.	
850,357	4/1907	Doyle	----- 128—234
3,316,909	5/1967	Cowley	----- 128—234 X

OTHER REFERENCES

Peters, J. P., et al.: Quantitative Clinical Chemistry, vol. II, Methods, 1932, Williams & Wilkins Co., Baltimore, pp. 64-66 relied on.

Aloe Laboratory Apparatus-Equipment-Reagents, Catalog No. 103, 1952, published by Aloe Scientific, St. Louis, Mo., p. 396 relied on.

MICHAEL E. ROGERS, Primary Examiner

U.S. Cl. X.R.

23—230, 258.5; 128—234; 210—460, 508; 260—113